CULTURAL TREATMENTS IN LOW-QUALITY HARDWOOD STANDS

FOR WILDLIFE AND TIMBER PRODUCTION 1/

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Abstract. -- Effective management of low-quality hardwood stands in the Interior Uplands of the Southeast is difficult but can yield increases in available deer browse and timber quality. This study tested two methods of clearcutting and prescribed burning of young stands as timber and wildlife management tools in low-quality hardwood stands of the Cumberland Plateau of East Tennessee. Complete and diameter limit clearcutting produced stands of similar composition and structure, both dominated by the species present before harvest. The removal of extra stems by complete clearcutting did not significantly increase browse availability as had been expected. Prescribed burning prolonged the availability of browse but produced few changes in species composition. However, available browse in all clearcuts was underutilized due to lack of forest cover. Pioneer species remained essentially absent after both methods of clearcutting and prescribed burning.

INTRODUCTION

Stands of low-quality hardwoods are widespread throughout the Interior Uplands of Alabama, Tennessee, and Kentucky. The Cumberland Plateau and Highland Rim Regions of Tennessee, for example, are nearly 67 percent forested with 3 million acres of commercial forest land (USDA Forest Service 1982). Less than 10 percent of this area, however, has at least 50 percent stocking with desirable growing stock trees (McGee 1982). Estimates of the precise acreage of low-quality hardwood stands in the Southeast vary, depending on how these stands are defined. In general, stands are considered to be of low-quality due to low stocking and/or a high proportion of trees classified as 'rough or rotten'.

Low-quality hardwood stands are generally the result of a long history of mismanagement or no management at all (TVA 1952, McGee 1982). Many stands are on sites capable of being highly productive. However, production is low due to repeated wildfires and high-grading in addition to a lack of protection from insects and disease. Effective management of these cull-burdened stands presents many problems (Trimble 1963), but also an opportunity for increased production of both wildlife and timber (McGee 1982). For management to be successful, the land manager must have an understanding of how various cultural treatments will affect the composition, quantity, and quality of resulting vegetation.

The Tennessee Wildlife Resources Agency (TWRA) manages the Catoosa Wildlife Management Area, an 80,000 acre block on the Cumberland Plateau of East Tennessee, much of which is forested with low-quality hardwood stands. The primary management objective for these stands is to improve habitat for white-tailed deer (*Odocoileus virginianus*) and wild turkey (*Meleagris gallopavo*) and also non-game species when possible (Arney and Pough 1983). Timber management is also of concern since this provides much of the funding for wildlife management. TWRA has tried several management schemes to improve the productivity of their low-quality hardwood stands while main-

1/ Paper presented at the Third Biennial Southern Silvicultural Research Conference, Atlanta, Georgia, November 7-8, 1984.

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taining quality habitat for deer and turkey. One such scheme has been to clearcut hardwood stands and allow coppice regeneration. Prescribed fires at 3 to 5 years after clearcutting have been used to keep browse within the reach of deer for longer periods of time.

A study was begun in 1978 to determine how these practices affect the structure and composition of resulting regeneration as well as the quality of deer habitat. This study was one phase of a project to develop a computer model of forest stand dynamics for the Catoosa Wildlife Management Area (Waldrop 1983). Preliminary results (Muncy 1980, Muncy and Buckner 1981) indicated that after one growing season, slightly larger numbers of seedlings and sprouts existed in areas that had been completely clearcut (all stems > 6 feet tall felled) than in areas which had been clearcut to a lower diameter limit of 3 inches (at breast height). Species composition was similar to that of the pre-harvest stand with few pioneer species present. The study was continued to (1) monitor further stand development after complete and diameter limit clearcutting, (2) determine how prescribed burning of young hardwood stands affects the composition and structure of regeneration, and (3) determine how clearcutting and prescribed burning affect the browsing preferences of deer.

STUDY AREA

The study is located on the Catoosa Wildlife Management Area in Cumberland County, Tennessee. The area is characterized as having moderately hot summers and short, mild winters. Mean monthly temperatures range from 35 degrees (Farenheit) in January to 73 degrees in July (USDC 1977). Rainfall averages 57 inches per year with extremes of 3 inches in October and 6 inches in January.

The study area is classified as land type 1 under Smalley's (1982) classification of forest sites on the Mid-Cumberland Plateau. Such areas are gently undulating to slightly rolling. Slopes of greater than 6 percent are uncommon so that aspect is not a dominant factor controlling species occurrences. Elevation ranges from 1,700 to 1,760 feet. Soils of the Hartsells and Lonewood series are dominant. Depth to bedrock is 20 to 40 inches with Hartsells series soils and 40 to 65 inches with Lonewood series soils (USDA 1974, 1975). Both soils are strongly acidic, moderately well drained, and of moderately low fertility (Smalley 1982).

Forests of the study area best fit the Society of American Foresters (SAF 1964) type 41 scarlet oak group which is within the Oak-Hickory Type Group. Mature forest stands were dominated by scarlet oak and post oak with Southern red oak and black oak as common associates (Table 1). (Scientific and common names of all species are included in the appendix). Pignut hickory, Virginia pine, white oak, blackjack oak, blackgum, red maple, and chestnut oak were also present. Major understory species included sourwood and dogwood.

METHODS

The study was established as a split-plot randomized complete block design to study the effects of two harvesting techniques, prescribe fire, and browse on the composition and quantit of regeneration. Each of two replications was divided into three 10-acre plots for the main treatments. Main treatments included (1) diame limit clearcutting, (2) complete clearcutting, and (3) uncut controls. Each main treatment pl was split into two 5-acre subplots, one of whicl was burned when regeneration grew out of reach for deer browsing. Nine permanent sampling poi were established in each subplot.

Animal exclosures, 1/40 acre in size, were selected around two randomly selected sampling points in each subplot. By using different size fencing, these exclosures were constructed so tl deer were excluded from the entire fenced-in are and rabbits and other small mammals were exclude from one-half of the area.

A buffer strip 100 feet wide was cut around both the diameter limit and complete clearcut plots to eliminate any edge effect. A total of acres was clearcut in one replication and 35 acr in the other. Uncut control plots were located near cut areas but away from any influence of logging operations.

Diameter limit and complete clearcut harves were completed by the early summer of 1979. Diameter limit cutting was defined as the remova of all stems over 3 inches dbh. This conforms t Tennessee Wildlife Resources Agency policy and was stipulated in contractual agreements with loggers. Complete clear-cutting was defined as the removal of all stems over 6 feet in height. The removal of stems between 6 feet in height an 3 inches dbh was accomplished after the commercial logging operation had been completed. Control plots were established to provide a comparison for other treatment plots.

Prescribed fires were conducted in each replication between the third and fourth growing seasons after harvest (early spring 1982). Burn were conducted on April 12, April 14, and May 2, 1982. Weather predictions called for winds of 1(to 15 miles per hour and low relative humidities of 40 percent. Rain had not fallen on the study areas for 4 days and 6 days, respectively for the first two burn dates. Rain had not fallen for 7 days prior to the third burn date. Due to gusty winds and high fire spread indices, all fires we set to burn into the wind (backing fire). Fires were set at 1:00 pm (Central Standard Time), 10:C am, and 11:00 am, respectively for the three burn dates.

Table 1.--Pre-harvest stand characteristics

Species	Sawtimber (11.0 in. and >) Av. No. Trees per Ac.	Basal Area/Ac. sq. ft.	Pulpwood (3.0 to 10.9 in. dbh) Av. No. Trees per Ac.	Basal Area/Ac. sq. ft.
Oaks				
Scarlet	13.6 (37%)	18.9 (44%)	18.3 (8%)	3.8 (9%)
Post	10.1 (28%)	9.3 (22%)	46.9 (21%)	13.5 (33%)
Southern Red	4.3 (12%)	4.9 (11%)	38.0 (17%)	6.4 (16%)
Black	3.9 (11%)	4.6 (11%)	24.1 (11%)	4.3 (10%)
White	.6 (2%)	.7 (2%)	16.7 (8%)	2.7 (7%)
Blackjack	.6 (2%)	.6 (1%)	1.7 (.9%)	.4 (1%)
Chestnut	.1 (.4%)	.1 (.3%)	- -	- -
Hickories				
Pignut	1.2 (3%)	1.7 (4%)	3.2 (2%)	.4 (1%)
Mockernut	.2 (.6%)	.2 (.6%)	1.9 (1%)	.3 (1%)
Other Potential Overtstory Hardwoods				
Blackgum	.4 (1%)	.5 (1%)	2.0 (1%)	.4 (1%)
Red Maple	.2 (.6%)	.3 (.8%)	2.2 (1%)	.3 (1%)
Understory Hardwoods				
Sourwood	.2 (.4%)	.1 (.3%)	32.2 (15%)	3.5 (.8%)
Dogwood	- -	- -	6.7 (3%)	.6 (1%)
Pines				
Virginia	.9 (2%)	.8 (2%)	23.5 (11%)	4.5 (11%)
Total	36.2 (100%)	42.7 (100%)	217.4 (100%)	41.1 (100%)

Inventories of all study plots were conducted prior to harvest. Each sawtimber-sized tree (11 in. dbh and >) located on each 1/5 acre subplot was mapped in relation to the plot center measured for height and dbh, and recorded by species. The same was done for each pulpwood-sized tree (3 to 10.9 in dbh) on 1/20 acre plots and each sapling-sized tree (6 ft. tall to 2.9 in. dbh) on 1/40 acre plots. Regeneration-sized trees (< 6 ft. tall) on 1/100 acre plots were tallied by species nad by the presence or absence of evidence of browse.

Similar inventories were conducted at the beginning and end of the third and fourth growing seasons after harvest (1 year before and 1 growing season after prescribed burning). Each tree in uncut control areas was tallied as either alive or dead. Uncut trees in clearcut areas were measured for height and dbh. If a tree had been cut, the number of basal, stump, and/or root sprouts produced by the stump was recorded. Regeneration in 1/100 acre plots was again tallied by the number of trees of each species and the number showing evidence of browse.

A factorial arrangement of the analysis of variance was used to test for differences in the number of stems for each of three factors. Factors included two methods of clearcutting (diameter limit and complete), 10 species, and two classes of saplings (seedlings and sprouts). T-tests were used to compare the sprouting characteristics observed in each type of clearcut.

RESULTS

Clearcutting Treatments

Regeneration following the third growing season after clearcutting was similar to the 1-year-old stand as described by Muncy and Buckn (1981). Slightly larger numbers of seedlings an sprouts of most species occurred in the complete clearcut areas than in areas harvested by the diameter limit method. However, this difference was not statistically significant and, therefore further discussion will characterize a single stand by combining data from both types of clear cuts.

After three growing seasons the total number of stems per acre was 6,168 (Table 2), an increa of 25 percent over the 1-year-old stand. Of thi total, 38 percent were seedlings and 62 percent were sprouts. The oak group composed 24 percent of the total regeneration while 38 percent was from other potential overstory hardwoods (including the hickories). Thirty-seven percent of the regeneration consisted of understory hard wood species while only 0.8 percent consisted o pines.

Scarlet oak was the most abundant oak speci with 651 seedlings and sprouts per acre. Black oak, Southern red oak, post oak, and white oak were also abundant with 343, 189, 151, and 111 stems per acre, respectively. Two species, bla gum and red maple, predominated in the category other potential overstory hardwoods. Blackgum

Table 2.--Regeneration three years after clearcutting (both cutting treatments combined)

Species	Seedlings	Sprouts	Total
Oaks	-------- Mean Number Per Acre (Percent) --------		
Blackjack	20.8 (0.9)	2.8 (0.1)	23.6 (0.4)
Scarlet	588.9 (24.8)	62.5 (1.6)	651.4 (10.6)
Black	255.6 (10.8)	87.5 (2.3)	343.1 (5.6)
Southern Red	116.7 (4.9)	72.2 (1.9)	188.9 (3.1)
Post	94.4 (4.0)	59.7 (1.6)	154.1 (2.5)
White	84.7 (3.6)	26.4 (0.7)	111.1 (1.8)
Hickories			
Pignut	59.7 (2.5)	88.9 (2.3)	148.6 (2.4)
Mockernut	11.1 (0.5)	9.7 (0.3)	20.8 (0.3)
Other Potential Overstory Hardwoods			
Blackgum	594.4 (25.0)	520.8 (13.7)	1115.2 (18.1)
Red Maple	115.6 (6.6)	831.9 (21.9)	987.5 (16.0)
Persimmon	31.9 (1.3)	6.9 (0.2)	38.8 (0.6)
Black Locust	41.7 (1.8)	- -	41.7 (0.7)
Understory Hardwoods			
Sassafras	111.1 (4.7)	1763.9 (46.5)	1875.0 (30.4)
Dogwood	63.9 (2.7)	165.3 (4.4)	229.2 (3.7)
Sourwood	30.6 (1.3)	77.8 (2.1)	108.4 (1.8)
Serviceberry	54.2 (2.3)	1.4 (0.1)	55.6 (0.9)
Am. Holly	9.7 (0.4)	1.4 (0.1)	11.1 (0.2)
Am. Chestnut	- -	15.3 (0.4)	15.3 (0.2)
Pines			
Virginia	45.8 (1.9)	- -	45.8 (0.7)
White	2.8 (0.1)	- -	2.8 (0.1)
Totals	2373.6 (100)	3794.4 (100)	6168.0 (100)

the most abundant of all overstory species with 1,115 stems per acre. Red maple had 988 stems per acre of which 832 (84 percent) were classified as sprouts.

Sassafras regeneration was the most abundant of the understory hardwoods with 1,875 stems per acre. The majority (94 percent) was of sprout origin. Dogwood and sourwood seedlings and sprouts were common and American holly seedlings were observed occasionally. Sprouts of American chestnut were present but infrequent.

The presence of pioneer species in study plots was smaller than had been expected. Virginia pine seedlings composed 0.7 percent of the total regeneration (46 seedlings per acre) while Eastern white pine accounted for only 0.1 percent (3 per acre). Yellow-poplar and black locust are common in the general area but were essentially absent from study plots. Since larger quantities of pioneer species were observed in the buffer areas around study plots, the distance from a seed source to study plots may partially account for their absence.

Sprouting remained the most common form of regeneration through the third growing season (Table 2). No significant differences were detected between diameter limit and complete clearcuts in the number of sprouts per cut tree or in the height of the dominant sprout from each stump. Although not statistically significant, the total number of stems per acre was slightly larger in complete clearcut areas than in diameter limit clearcuts. This increase was due to the greater number of understory hardwoods harvested in the complete clearcuts and the prolific sprouting characteristic of some of these species, particularly sassafras. The increased sprouting of understory hardwoods in complete clearcut areas is potentially beneficial to wildlife for browse but is of little value to timber management.

Significant differences in sprouting characteristics occurred between the various size classes and species of trees harvested. Seventy-seven percent of the stumps of sapling-sized trees had live sprouts after 3 years. However, this percentage decreased with increased stump size. Thirty-nine percent of the stumps of pulpwood-sized trees had live sprouts while only 4 percent of the stumps of sawtimber-sized trees sprouted. Of all species, red maple was the most prolific sprout producer with 6.2 and 14.8 sprouts per cut stem for sapling- and pulpwood-sized trees, respectively. For most species, basal sprouts were the most abundant of the three types of sprouts observed (basal, stump, and root sprouts). This indicates that stumps should be cut as low as possible for well-formed coppice regeneration.

Prescribed Burning

The prescribed burn conducted on the third burn date (May 2) was blown across plowed fire lines by gusty winds. As a result, all clearcut plots in one replication were burned. Since this left no comparison of regeneration in burned and unburned plots, no statistical tests of the effects of prescribed burning were possible. Many effects were obvious, however, and will be discussed.

One year after burning, sprouts remained more abundant than seedlings. Most stumps that had live sprouts before burning resprouted after the fire (Table 3). This trend varied somewhat by species and diameter class. Seventy-nine percent of the stumps from sapling-sized trees that were alive just prior to burning survived the fire. Survival rates of the oaks in this size class were generally above 60 percent. Black oak, white oak, and Southern red oak had survival rates of 95, 83, and 88 percent, respectively. Other species in the sapling size class with good survival rates included mockernut and pignut hickories, blackgum, red maple, sassafras, and sourwood. Of the survivors in the pulpwood size class, the oaks were the most abundant. Black oak had the best survival rate of all species observed in this size class. Very few sawtimber-sized stumps had sprouts before burning. Of those that did, stumps of scarlet oak and pignut hickory had excellent survival rates.

Prescribed burning produced few changes in species composition. Study plots in both burned and unburned clearcuts had a large component of oaks (Table 4). In both areas, stems of black oak and scarlet oak were the most abundant oak species. The oaks as a group made up 22.6 percent of the stem count in unburned plots and 18.8 percent in burned plots. This difference may be due to the sprouting characteristics of sassafras and blackgum. Burning may have stimulated the sprouting of sassafras and blackgum as shown by the large increase in the stem numbers of these species in burned plots. These two species combined had over 6,600 stems per acre in burned plots which was almost equal to the total number of stems in unburned plots (7,178). The numbers of oak stems remained relatively unchanged after burning. Burned plots had a total of 1,945 oak stems per acre while unburned plots had 1,622. However, with the large increase in the numbers of blackgum and sassafras stems, oak percentages decreased.

An opposite trend after burning was observed with red maple. Even though red maple was a prolific sprouter and had good sruvival rates (Table 3), the average number of stems per acre was much smaller in burned plots than in unburned plots.

Table 3.--Survival of stumps in complete and diameter clearcuts after prescribed fire

Species	Sapling (6' tall-2.9" dbh)		Pulpwood (3.0"-10.9"dbh)		Sawtimber (11.0" dbh and >)	
	No. alive before burning	No. alive after burning	No. alive before burning	No. alive after burning	No. alive before burning	No. alive after burning
		(%)		(%)		(%)
Oaks						
Blackjack	2	0 (0)	2	0 (0)	-	- -
Scarlet	14	8 (57)	36	25 (69)	7	5 (71)
Black	56	53 (95)	18	15 (83)	-	- -
White	24	20 (83)	26	15 (58)	-	- -
Southern Red	33	29 (88)	23	15 (65)	-	- -
Post	22	14 (64)	14	10 (71)	3	1 (33)
Hickories						
Mockernut	9	8 (89)	3	3 (100)	-	- -
Pignut	50	41 (82)	-	- -	3	2 (67)
Other Potential Overstory Hardwoods						
Blackgum	79	60 (76)	-	- -	1	0 (0)
Red Maple	7	5 (71)	2	0 (0)	-	- -
Understory Hardwoods						
Am. Chestnut	2	0 (0)	-	- -	-	- -
Am. Holly	2	2 (100)	-	- -	-	- -
Serviceberry	1	0 (0)	-	- -	-	- -
Sassafras	83	67 (81)	-	- -	-	- -
Sourwood	20	15 (75)	65	41 (63)	-	- -
Dogwood	16	10 (63)	7	4 (57)	-	- -
Totals	420	332 (79)	196	128 (65)	11	8 (72)

This difference may be due to the distribution of red maple through the study plots rather than to burning. Before burning, the distribution of red maple was observed to be patchy. Stems of this species appeared to be more abundant in plots that were to be left unburned. Had red maple been more uniformly distributed, it may have shown a different response to fire.

Table 4.--Regeneration one year after prescribed burning (four years after clearcutting)

Species	Burned	Unburned
	----- Stems Per Acre (%) -----	
Oaks		
Scarlet	779.6 (7.5)	500.1 (7.0)
Black	453.7 (4.4)	716.7 (10.0)
Southern Red	359.3 (3.5)	161.1 (2.2)
Post	209.3 (2.0)	138.9 (1.9)
White	138.9 (1.3)	105.6 (1.5)
Chestnut	3.7 (0.1)	- -
Hickories		
Pignut	112.0 (1.1)	249.9 (3.5)
Mockernut	22.2 (0.2)	39.0 (0.5)
Other Potential Overstory Hardwoods		
Blackgum	2,631.5 (23.5)	750.0 (10.4)
Red Maple	296.3	1,105.5 (15.4
Persimmon	14.9	55.5 (0.8)
Black Locust	270.4	166.8 (2.3)
Black Cherry	1.9	5.7 (0.1)
Yellow-poplar	-	11.1 (0.2)
Understory Hardwoods		
Sassafras	4,050.0 (39.2)	2,177.7 (30.3)
Dogwood	187.0 (1.8)	183.3 (2.6)
Sourwood	446.3 (4.3)	583.2 (8.1)
Serviceberry	5.6 (0.1)	50.1 (0.7)
Am. Holly	11.1 (0.1)	16.8 (0.2)
Am. Chestnut	5.6 (0.1)	111.1 (1.5)
Winged Sumac	357.4 (3.5)	5.7 (0.1)
Pines		
Virginia	7.4 (0.1)	44.7 (0.6)
Totals	10,339.0	7,178.4 (100)

The frequency of pines and other pioneer species remained low in both burned and unburned plots. Virginia pine was the only pine species observed, although shortleaf pine and Eastern white pine are native to the region. The average number of Virginia pine seedlings per acre was 44.7 in unburned plots and only 7.4 in burned plots. Yellow-poplar was observed in unburned plots at the rate of only 11.1 seedlings per acre. No seedlings or sprouts of this species were found in burned plots.

The structure of regeneration was also unchanged by prescribed burning. Basal sprouts remained the most common form of regeneration in both burned and unburned plots. A few root sprouts were observed near stumps of pignut hickory, blackgum, and sassafras while an occassional stump sprout of scarlet oak or dogwood was observed.

Browsing

The incidence of browsing in study areas was minimal. During data collection at the end of t fourth growing season (1982), over 7,000 regeneration-sized trees were observed. Of thes only 93 showed evidence of browse. This number even smaller at the end of the third growing season. Therefore, it was assumed that browsing had no affect on the structure and composition o regeneration. In addition, no comparisons were made on deer preferences to browsing in diameter limit or complete clearcuts as well as burned or unburned clearcuts.

Muncy (1980) noted that browsing occurred mo often along haul roads and skid trails within st plots. This trend was repeated during the third and fourth growing seasons. Of those species th were browsed, sassafras and blackgum sprouts wer most common. Blackgum is listed as a preferred species for deer browse in Tennessee while sassafras is listed as a common food (Hurd 1980). Occassional browsing of black oak, pignut hickor and red maple was also observed.

The location of sampling points within clearcut areas may offer an explanation for the small number of browsed stems observed. Sampling point were located near the center of nearly square-sha 30 and 35 acre clearcuts. Buffer strips, 100 fee wide, were cut around study plots further isolati points near the center of large cuttings. More evidence of browsing was observed in buffer stri than within sampling plots. This may have been d to the proximity of buffer strips to cover provid by the forest edge. Buffer strips were large enc and contained sufficient browse that deer likely remained in these areas rather than entering stud plots. Also, study plots were in a heavily hunte area where deer are not likely to wander far from the protective cover of a forest stand.

Observations of browsing may be more valuable in future studies as stands close and much of the regeneration in buffer areas is shaded out. Unde these conditions, browsing animals will have to cover a larger area to obtain food, possibly causing a more noticeable impact on species composition and tree growth rates in study plots.

DISCUSSION

Species composition of regeneration after cle cutting a low-quality hardwood stand was largely a function of the sapling-and pulpwood-sized tree harvested. Sprouts from cut stems of these size classes composed a large portion of the regenerat stand since pioneer species and sprouts from sawtimber-sized trees were essentially absent. Seed lings that were a component of the regenerated st tended to be of the same species as the harvested trees, suggesting that root suckering may be more important than visual observation would indicate.

Regeneration and stand development were relatively unaffected by the choice of either diameter limit or complete clearcutting methods. Both treatments resulted in stands that were approximately 24 percent oak, 3 percent hickory, and 34 percent blackgum and red maple, with the remainder being mostly sassafras (Table 2). Even though large stumps tended not to produce sprouts, the extra expense of harvesting stems between 6 feet in height and 3 inches dbh in a complete clearcut proved to be of little value in terms of improved timber quality and wildlife habitat. A sufficient number of small stems was harvested by the diameter limit method to produce large numbers of sprouts. Seed germination provided an additional quantity of stems resulting in adequate stand regeneration and browse availability. Therefore, diameter limit clearcutting would be recommended over complete clearcutting for stands that have a sufficient quantity of pulpwood-sized trees (3.0 to 10.9 in. dbh) to yield adequate coppice regeneration. Prior to harvest, almost 50 percent of the basal area in the stand used for this study was from pulpwood-sized trees. Complete clearcutting should only be necessary where the pulpwood-sized component of the stand is much smaller.

Prescribed burning of young clearcuts proved to be of little value in terms of controlling species composition. Regeneration observed one year after burning was very similar to that observed the first year after clearcutting. Species composition was similar in burned and unburned plots, both being dominated by oak seedlings and sprouts.

Prescribed burning had a greater affect on browse availability than on species composition or structure. The most obvious differences between burned and unbruned plots were the sizes and ages of the regeneration. Burned clearcuts had small 1-year-old seedlings and sprouts while unburned clearcuts had larger 4-year-old seedlings and sprouts. Although the unburned clearcuts were still young, regeneration was beginning to grow out of the reach of deer. Prescribed burning top-killed most stems resulting in continued sprouting. Therefore, browse should remain within reach for several additional years.

Even though burning created favorable conditions for deer, browsing was minimal in study plots. However, evidence of heavy browsing was observed in buffer strips around study plots. Future recommendations for prescribed burning of young clearcuts should include considerations of the size and shape of the clearcut. In a large or wide clearcuts, such as those used in this study, prescribed burning may be of little actual benefit to deer. Since the majority of the clearcut area is relatively far from cover, particularly after the removal of logging debris by burning, it is not likely to be utilized intensively by deer. Burning may be of greater value to deer in smaller or more narrow clearcuts where a larger percentage of the area is near protective forest cover.

Prescribed burning provided several benefits for timber management including improved accessability to the site, protection from wildifre, and improved sprout quality. Logging debris was abundant in all clearcut areas before burning, creating a physical barrier to travel. Since the slash had cured for almost four years, it also represented a dangerous wildfire hazard. Prescribed burning provided an inexpensive method for slash removal. Sprout quality was improved by burning the tops of stumps. Therefore, resulting sprouts originated from a point closer to the ground which should lower the rate of decay (Roth and Sleeth 1939, Huntley and McGee 1981).

In summary, diameter limit clearcutting followed by natural regeneration proved to be an adequate management technique for timber and deer management considerations in low-quality hardwood stands. Complete clearcutting provided extra expense with few beneficial results. Prescribed burning improved browse availability by keeping it within reach of deer for a longer time period. However, this additional browse was not utilized possibly due to the size and shape of clearcuts. Prescribed burning proved to be more beneficial for timber stand improvement than for enhancing habitat for deer. Stand composition and structure appeared to be affected more by species composition before harvest than by choice of clearcutting method, prescribed burning, or browsing. Most regeneration in burned and unburned areas of both complete and diameter limit clearcuts consisted of sprouts from the stumps of sapling- and pulpwood-sized trees.

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APPENDIX

COMMON AND SCIENTIFIC NAMES OF TREE SPECIES

Common Name	Scientific Name
Red Maple	*Acer rubrum* L.
Sugar Maple	*Acer saccharum* Marsh.
Serviceberry	*Amelanchier arborea* var. *laevis* Wieg.
American Chestnut	*Castenea dentata* Marsh.
Pignut Hickory	*Carya glabra*
Mockernut Hickory	*Carya tomentosa* Nutt.
Dogwood	*Cornus florida* L.
Persimmon	*Diospyros virginiana* L.
American Holly	*Fraxinus americana* L.
Yellow-poplar	*Liriodendron tulipifera* L
Blackgum	*Nyssa sylvatica* Marsh.
Sourwood	*Oxydendron aroboreum* L.
Shortleaf Pine	*Pinus echinata* Mill.
Eastern White Pine	*Pinus strobus* L.
Virginia Pine	*Pinus virginiana* Mill.
Black Cherry	*Prunus serotina* Ehrh.
White Oak	*Quercus alba* L.
Scarlet Oak	*Quercus coccinea* Muenchh.
Southern Red Oak	*Quercus falcata* Michx.
Blackjack Oak	*Quercus marilandica* Muenc.
Chestnut Oak	*Quercus prinus* L.
Post Oak	*Quercus stellata* Wangenh.
Black Oak	*Quercus velutina* Lam.
Winged Sumac	*Rhus copallina* L.
Black Locust	*Robinea pseudoacacia* L.
Sassafras	*Sassafras albidum* Nutt.

WALDROP

United States
Department of
Agriculture

Forest Service

Southern Forest Experiment Station

New Orleans,
Louisiana

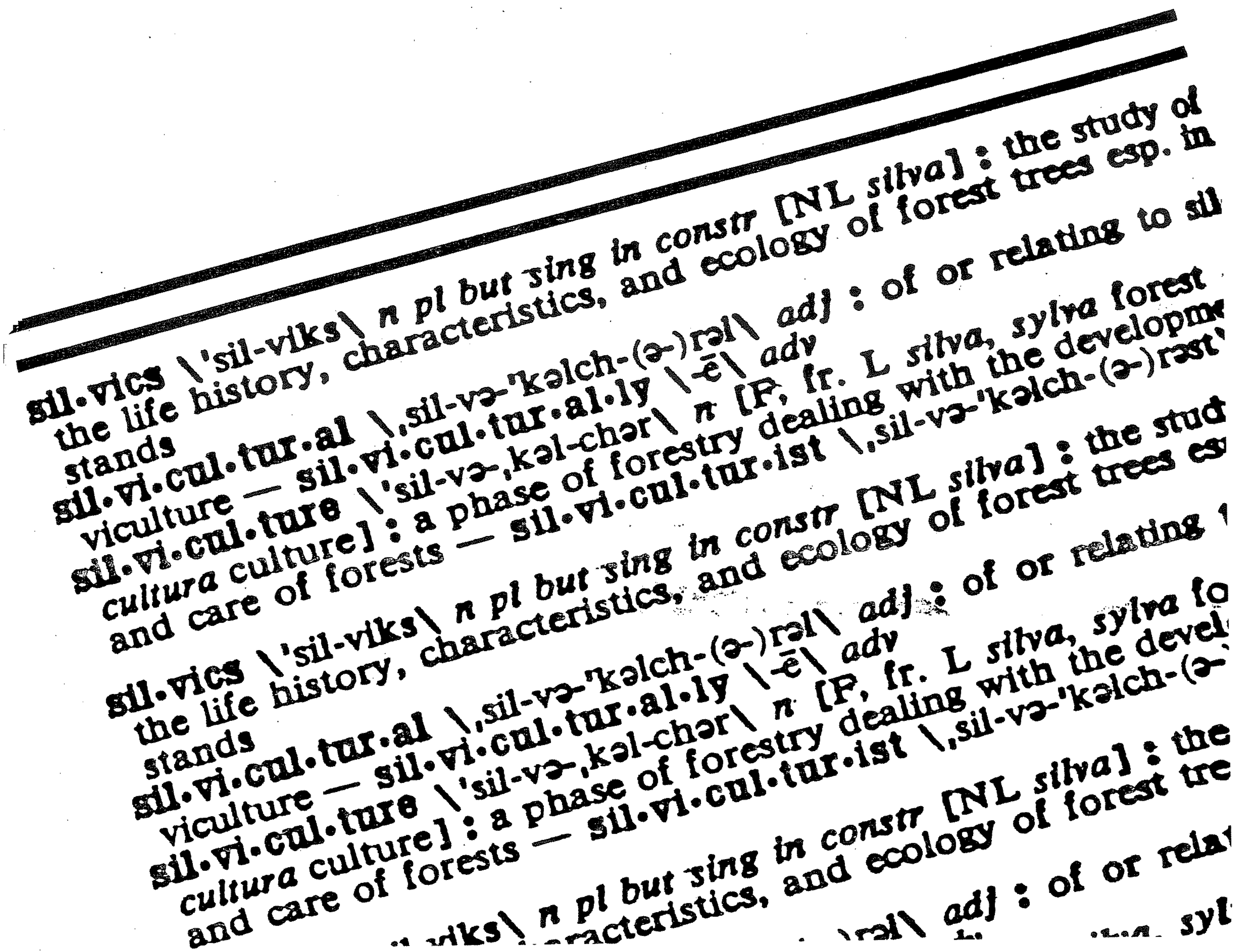
General Technical Report
SO-54
April 1985

Proceedings of the

Third Biennial Southern Silvicultural Research Conference

Atlanta, Georgia
November 7-8, 1984

Edited by
Eugene Shoulders



Shoulders, Eugene, ed.
Proceedings of the third biennial southern silvicultural research conference; 1984 November 7-8; Atlanta, GA: Gen. Tech. Rep. SO-54. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, 1985. 589 p.

107 papers are presented in 13 categories: Seedling production, Site preparation, Stand establishment, Stand management, Genetics, Vegetation management, Soil-site relationships, Tree nutrition, Symbiotic relationships, Growth and yield modeling, Pest management strategies, Interactions, and Forest influences.

Proceedings

of the

THIRD BIENNIAL SOUTHERN SILVICULTURAL RESEARCH CONFERENCE

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